NASA Institute for Advanced Concepts

NIAC Overview for the NASA-JPL/MSFC/AIAA Twelfth Annual Advanced Space Propulsion Workshop – April 3-5, 2001

NIAC Mission

- **Focus on Revolutionary Advanced Concepts for Architectures and Systems**

- **Be an institute independent of NASA**
  - **-- Management and guidance external to NASA**
  - **-- Non-NASA (mostly) peer review**
  - **-- NIAC issues and manages research grants/contracts**
  - **-- Contractually reports to GSFC with funding from NASA HQ**

- **Operate as a virtual institute over the internet (http://www.niac.usra.edu)**
  - **-- Calls for proposals issued through NIAC website**
  - **-- Proposals only accepted electronically**
  - **-- All abstracts, reports, weblinks and presentations are available on NIAC website**

- **Succinct technical proposal requirements and peer review**
  - **-- Phase I (12 pages), Phase II (25 pages)**
  - **-- Typical evaluation process, 2-2.5 months from proposal receipt to award**

"Don't let your preoccupation with reality stifle your imagination"

Robert A. Cassanova and Sharon M. Garrison

NIAC Advanced Concepts

In the context of NIAC requirements, successful proposals for advanced concepts will be:

- **Revolutionary, new and not duplicative of previously studied concepts,**
- **An architecture or system, and not a technology development**
- **Described in a NASA mission context,**
- **Adequately substantiated with a description of the scientific principles that form the basis for the concept,**
- **Largely independent of existing technology or a unique combination of systems and technologies.**

Definitions: Phase I and II

PHASE I *6 months* $50 - 75K	PHASE II *up to 24 months* up to $500K
① Is the concept revolutionary rather than evolutionary? To what extent does the proposed activity suggest and explore creative and original concepts? ② Is the concept for an architecture or system, and have the benefits been qualified in the context of a future NASA mission? ③ Is the concept substantiated with a description of applicable scientific and technical disciplines necessary for development?	① Does the proposal continue the development of a revolutionary architecture or system in the context of a future NASA mission? Is the proposed work likely to provide a sound basis for NASA to consider the concept for a future mission or program? ② Is the concept substantiated with a description of applicable scientific and technical disciplines necessary for development? ③ Have enabling technologies been identified, and has a pathway for development of a technology roadmap been adequately described? ④ Has the pathway for development of a cost of the concept been adequately described and are costing assumptions realistic? Have potential performance and cost benefits been quantified?

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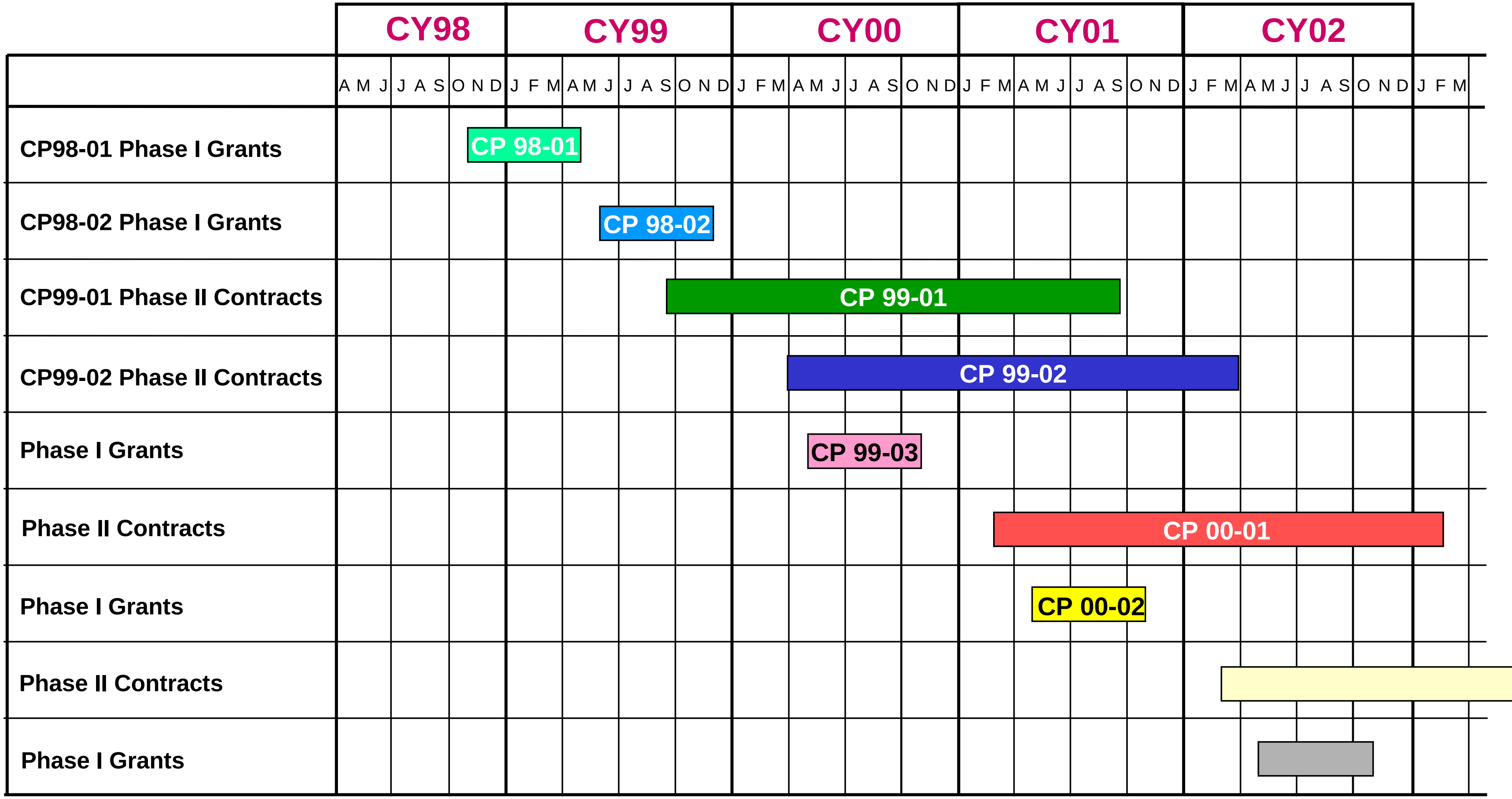

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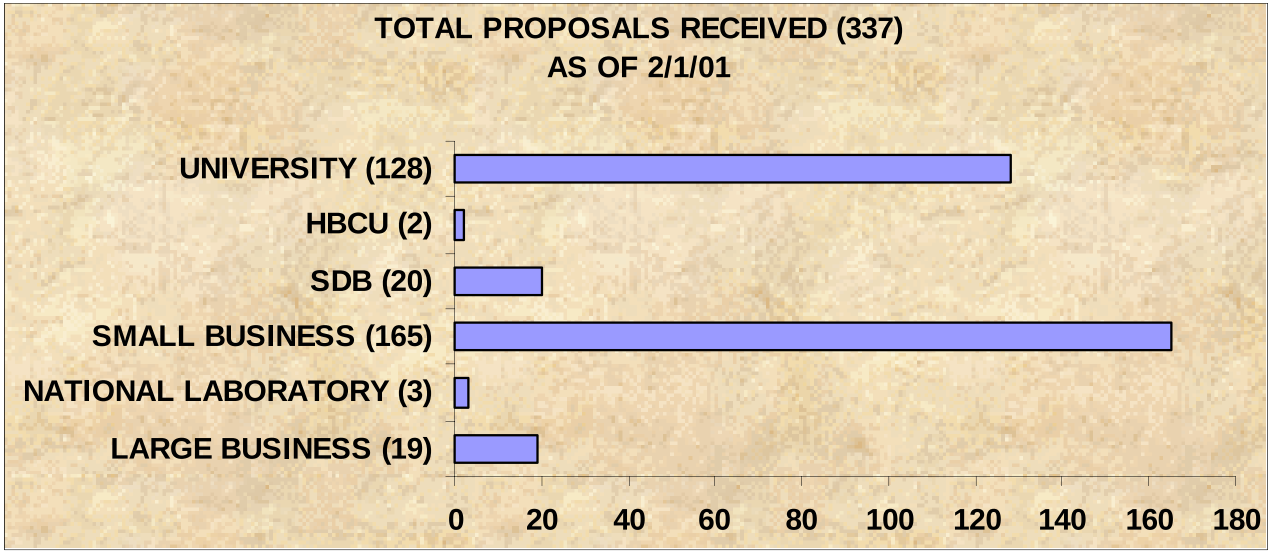
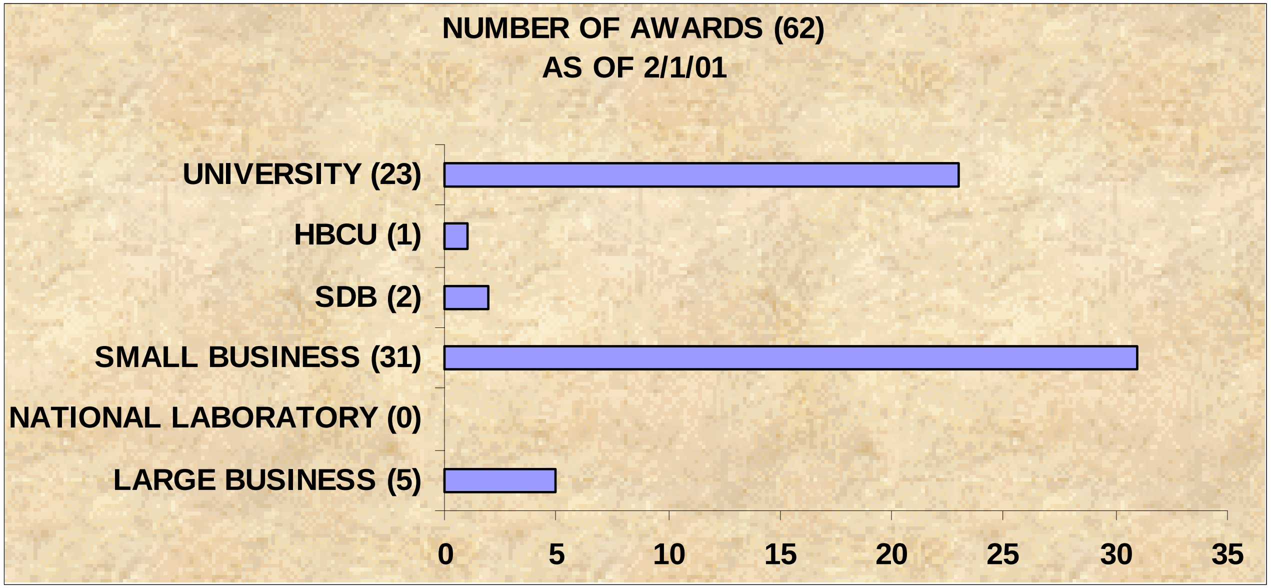
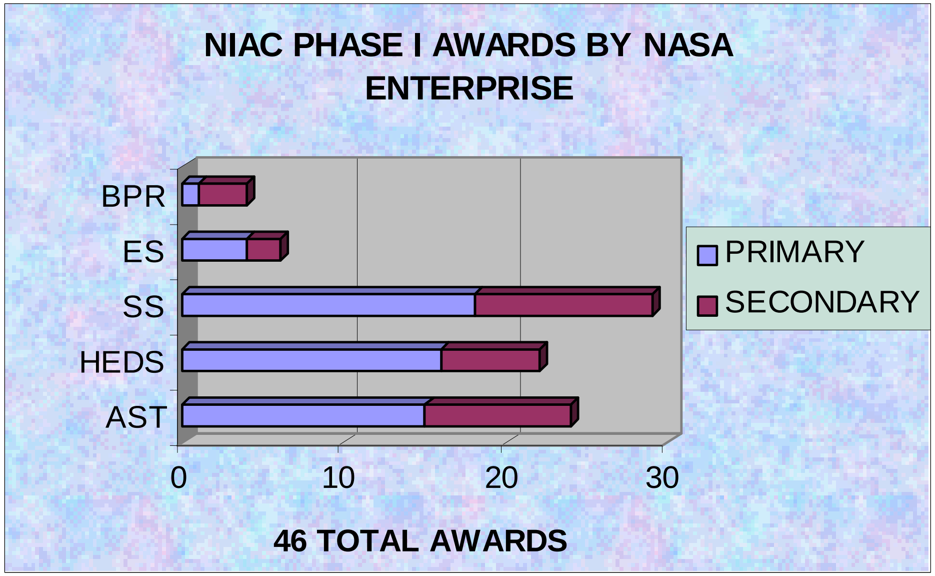
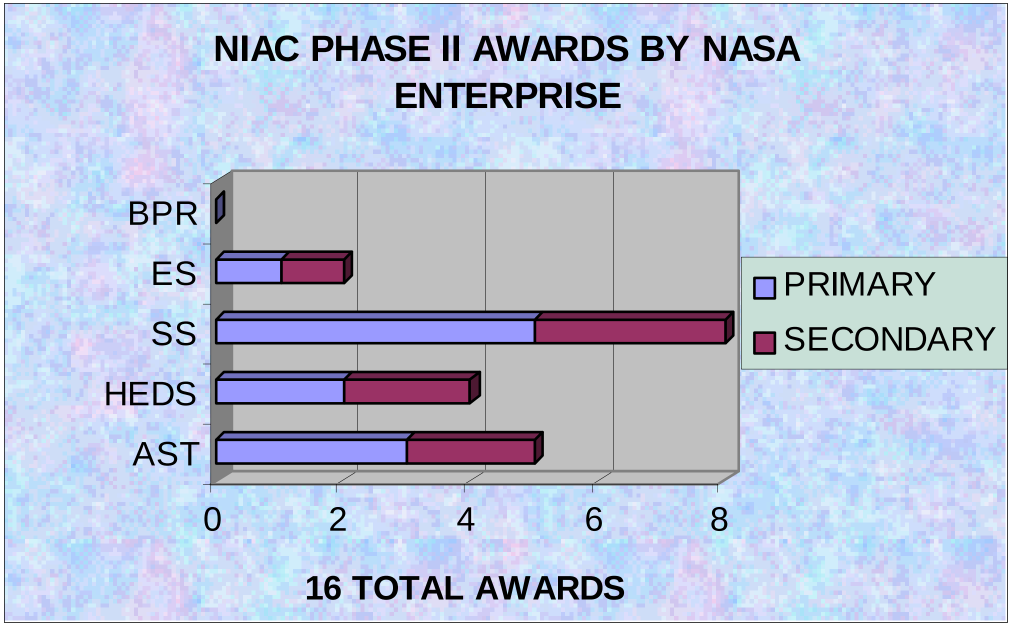
Proposals Received and Awards
(through February 1, 2001)





NIAC Awards (through March, 2001)

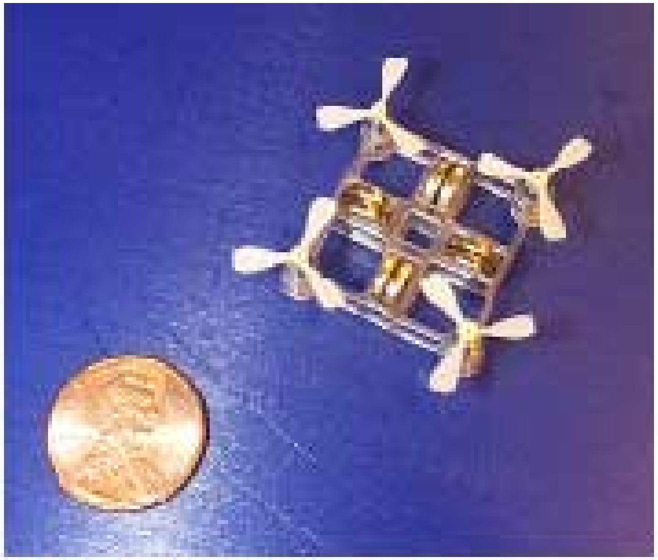




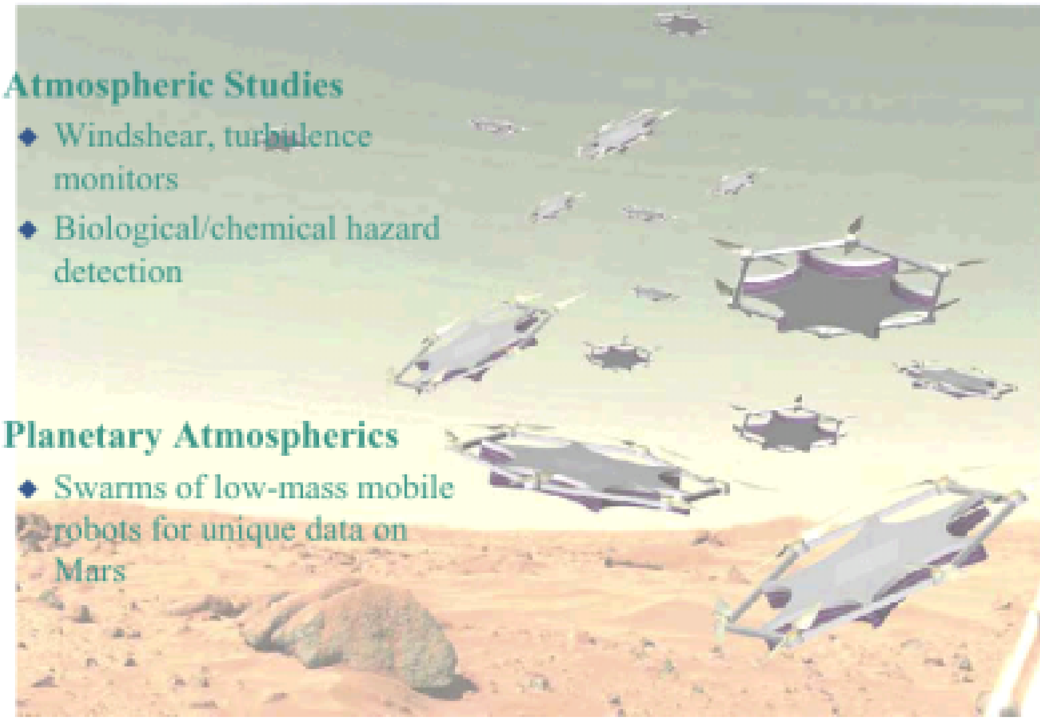
NASA Institute for Advanced Concepts

CP 99-01 Phase II Awards

PI Name and Organization	Advanced Concept Title
Kroo, Ilan *Stanford University*	Meso-Scale Flight Vehicle for Atmospheric Sensing
Dubowsky, Steven *Massachusetts Inst. Of Technology*	Self-Transforming Robotic Planetary Explorers
Hoyt, Robert *Tethers Unlimited, Incorporated*	Moon and Mars Orbiting Spinning Tether Transport (MMOSTT) Architecture
Winglee, Robert *University of Washington*	The Mini-Magnetospheric Plasma Propulsion System, M2P2
Woolf, Neville *University of Arizona*	Very large Optics for the Study of Extrasolar Terrestrial Planets
Gorenstein, Paul *Smithsonian Institution Astrophysical Observatory*	An Ultra-High Throughput X-Ray Astronomy Observatory with A New Mission Architecture



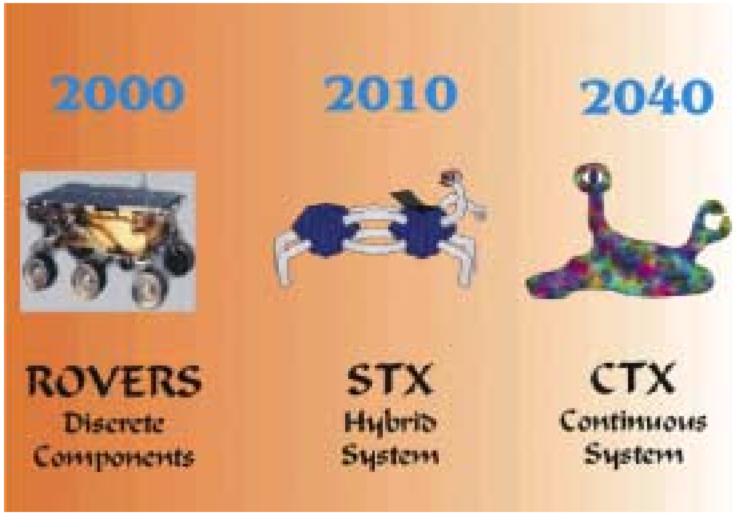
The Concept: Applications

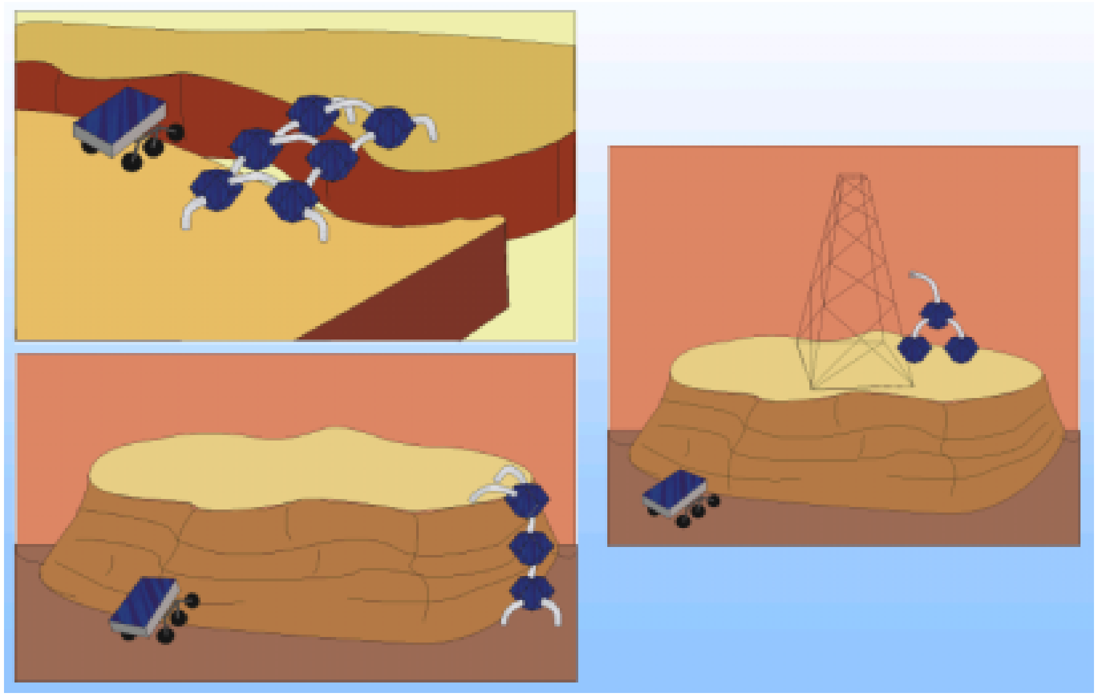


- **Atmospheric Studies**
  - Windshear, turbulence monitors
  - Biological/chemical hazard detection
- **Planetary Atmospherics**
  - Swarms of low-mass mobile robots for unique data on Mars

Self-Transforming Robotic Planetary Explorers

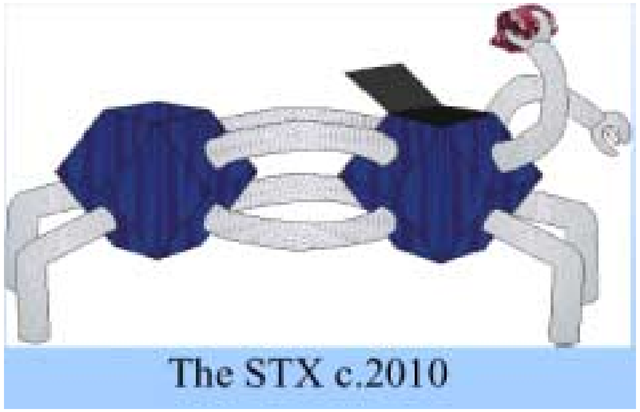
Steven Dubowsky, Massachusetts Institute of Technology





<u>Self- Transforming Explorer/ Worker Robot Concept (2010)</u>

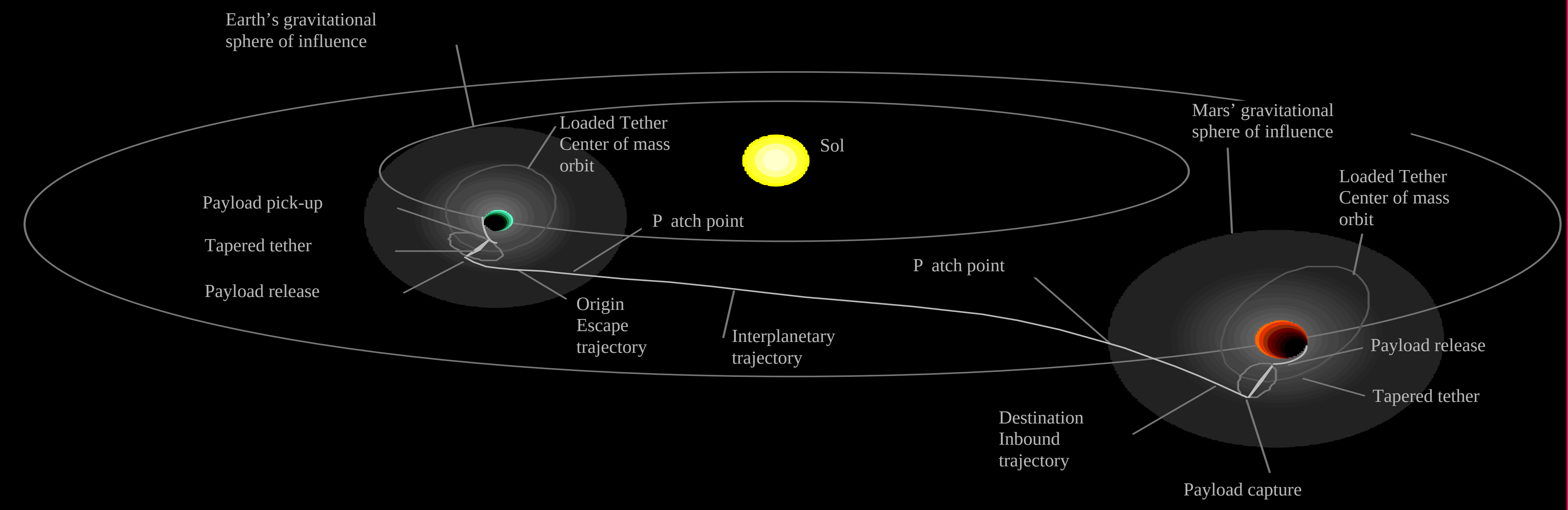
- **Network of Node Elements**
- **Connected by Active Binary Elements (ABEs)**



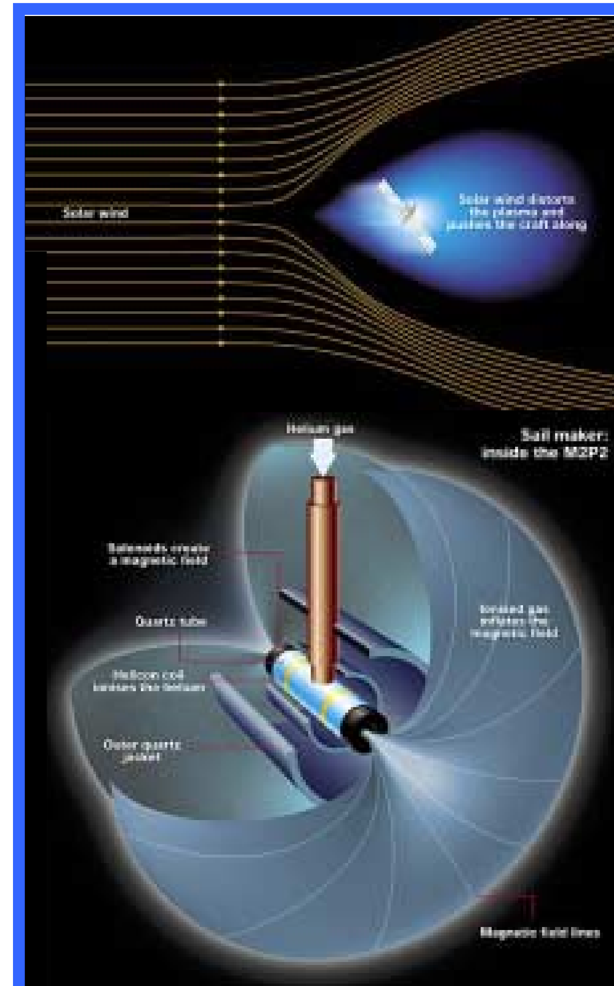
Moon and Mars Orbiting Spinning Tether Transport (MMOSTT) Architecture

Robert P. Hoyt, Tethers Unlimited, Inc.

INTERPLANETARY TRANSPORT USING ROTATING TETHERS



Concept for interstellar propulsion and radiation shielding



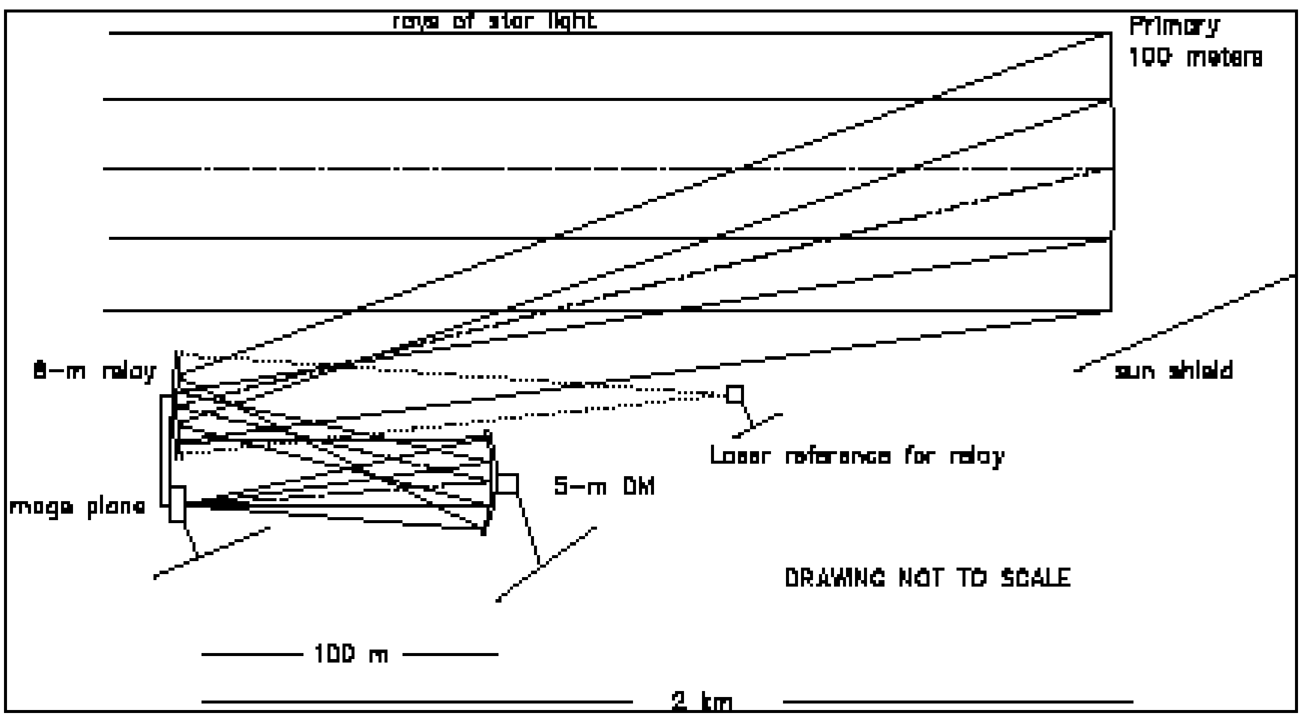
Graphics by permission of *New Scientist*

Hubble Space Telescope (operational)

Next Generation Space Telescope (technology development)

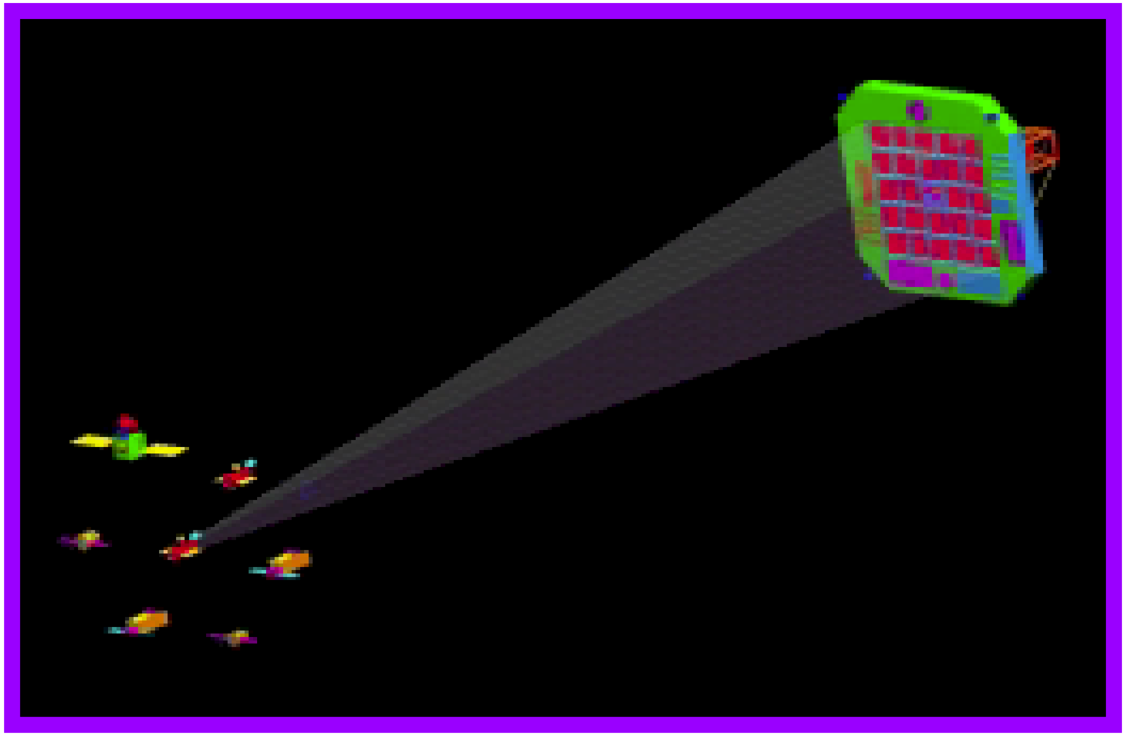
Terrestrial Planet Finder (concept development)

Life Finder



An Ultra-High Throughput X-Ray Astronomy Observatory with A New Mission Architecture

Paul Gorenstein, Smithsonian Institute, Astrophysical Observatory



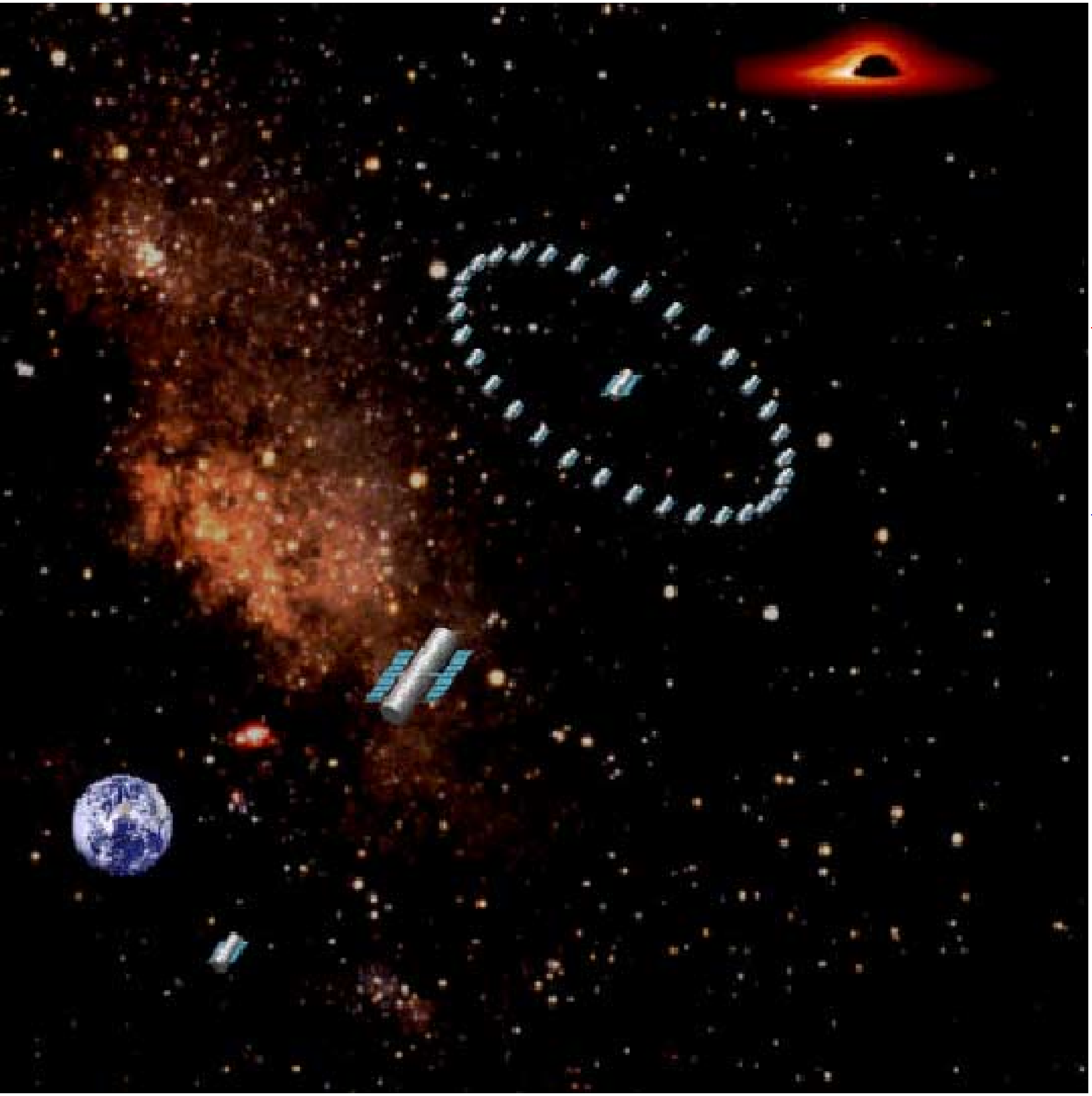
- 30m diameter, 300m focal length, arcsecond resolution
- Physically detached, station-kept components
- Located at L2 point
- Accommodate large variety of detectors
- Not dependent on success of single launch
- Potentially low cost per effective collector area
- Development of light weight, high performance X-ray reflectors
- Propulsion for LEO to L2, attitude control and highly accurate linear movements
- Missions operation and robotic assembly of telescope

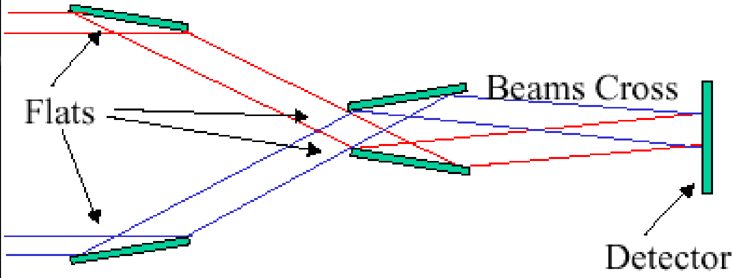
CP 99-02 Phase II Awards

PI Name and Organization	Advanced Concept Title
Cash, Webster ***University of Colorado***	**X-Ray Interferometry**
Grant, John ***The Boeing Corporation***	**Hypersonic Airplane Space Tether Orbital Launch (HASTOL) Study**
McNutt, Ralph ***The Johns Hopkins University***	**A Realistic Interstellar Explorer**
Nock, Kerry ***Global Aerospace Corporation***	**Global Constellation of Stratospheric Scientific Platforms**
Rice, Eric ***Orbital Technologies Corp.***	**Advanced System Concept for Total ISRU-Based Propulsion and Power Systems for Unmanned and Manned Mars Exploration**

X-ray Interferometry - Ultimate Astronomical Imaging

Webster Cash, University of Colorado





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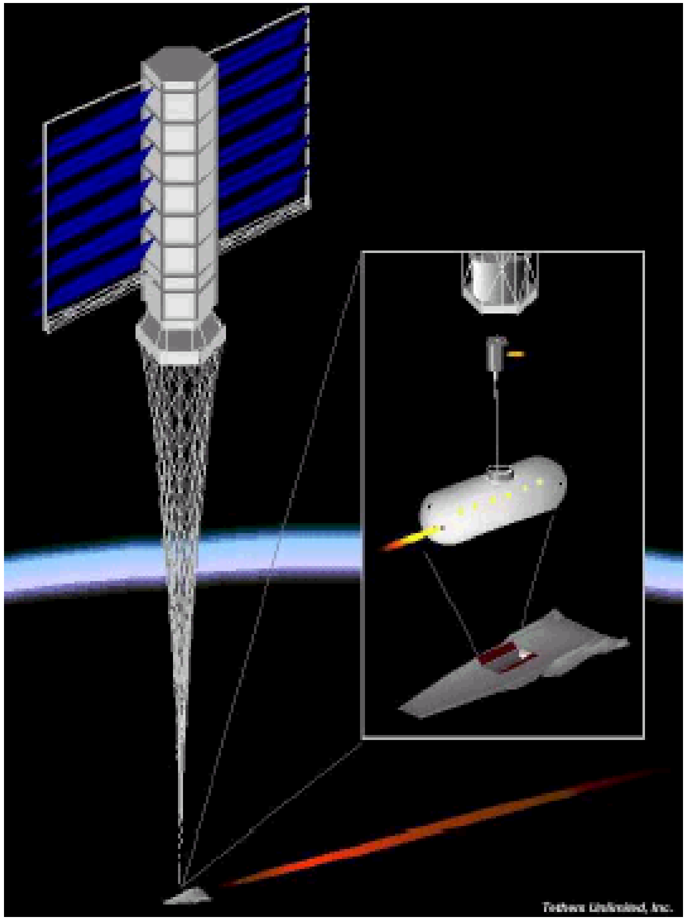
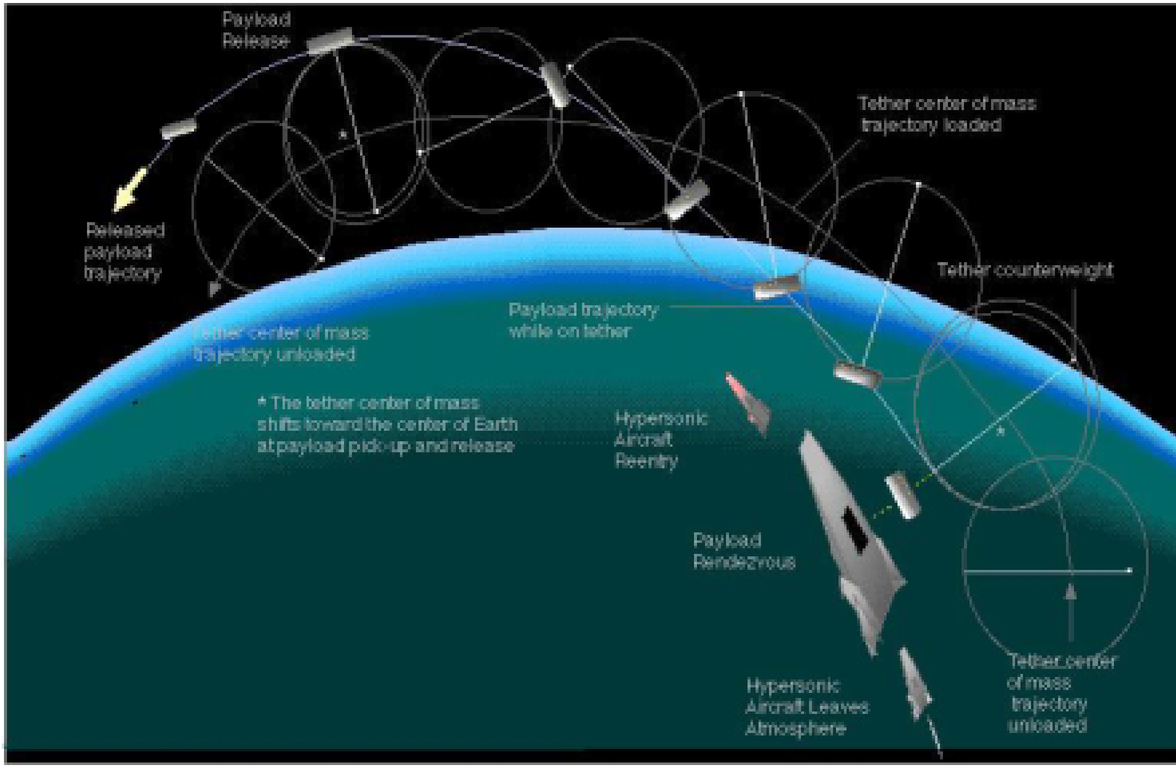
Hypersonic Airplane Space Tether Orbital Launch – HASTOL

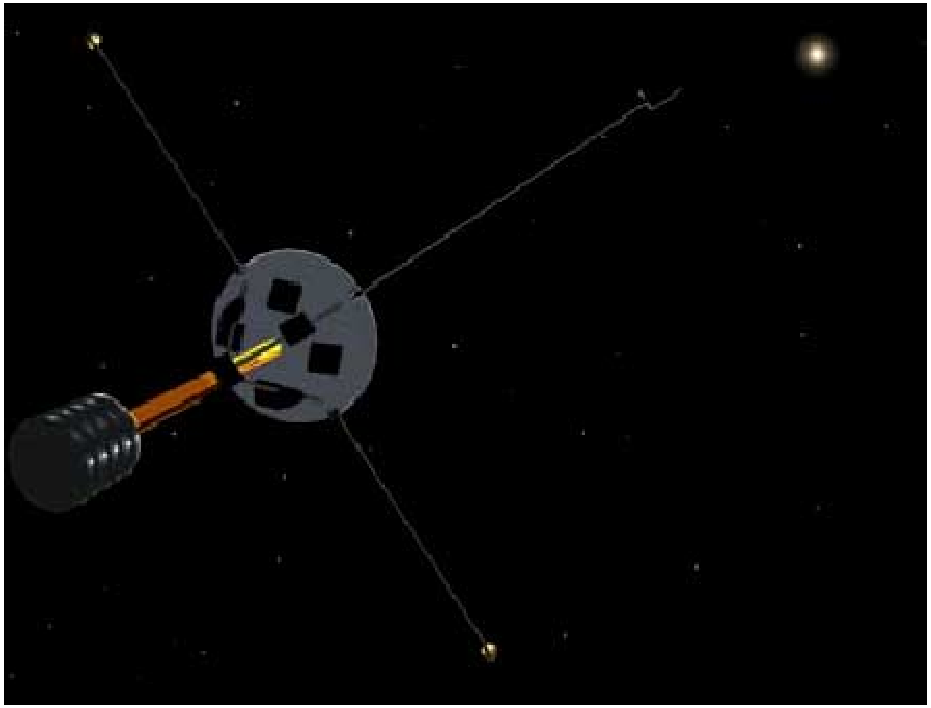
John Grant, The Boeing Company





A Realistic Interstellar Explorer

Ralph McNutt, Jr., Johns Hopkins Applied Physics Lab



- A mission past the boundary of the heliosphere would yield a rich scientific harvest.
- Explore the nature of the interstellar medium and its implications for the origin and evolution of matter in the Galaxy.
- Explore the structure of the heliosphere and its interaction with the interstellar medium.
- Explore fundamental astrophysical processes occurring in the heliosphere and the interstellar medium.
- Determine fundamental properties of the universe (e.g. big-bang, nucleosynthesis, location of gamma-ray bursts (GRRs), gravitational waves, and a non-zero cosmological constant.

MISSION CONCEPT

- Reach a significant penetration into the Very Local Interstellar Medium — out to ~1000 AU — within the working lifetime of the probe developers (< 50 years)
- To reach high escape speed, use a solar gravity assist (due to Oberth, 1929):

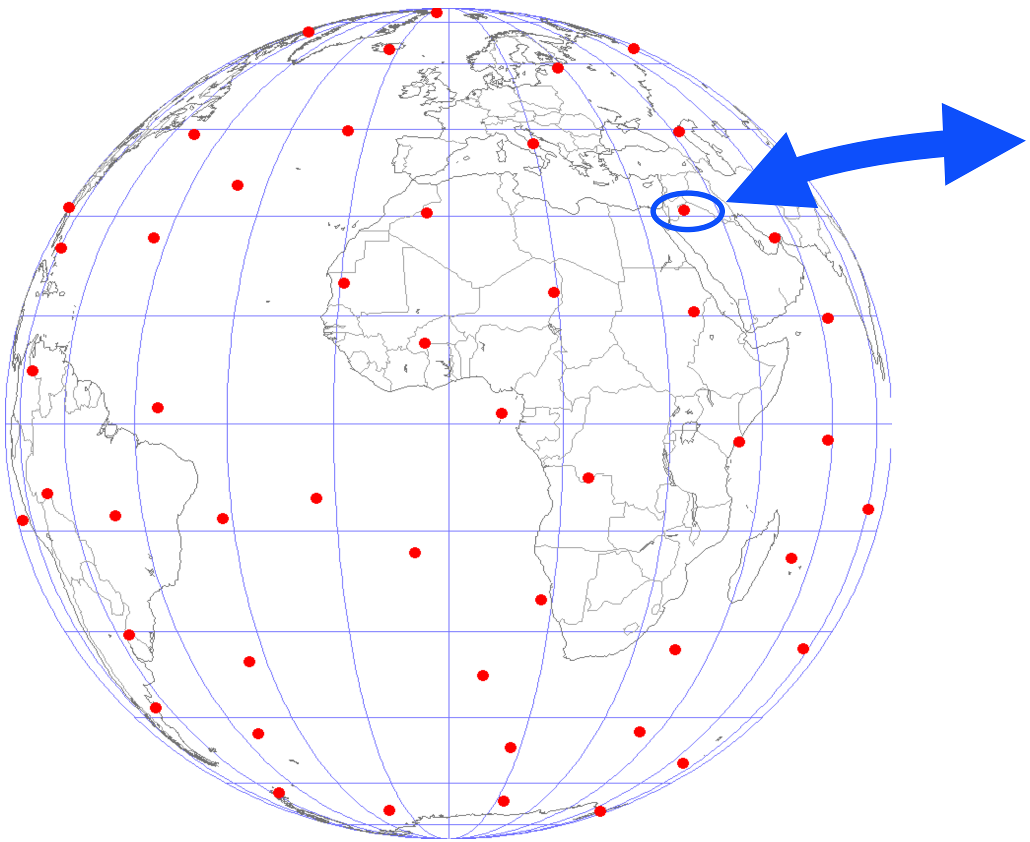
  (1) Launch to Jupiter and use a retrograde trajectory to eliminate heliocentric angular momentum

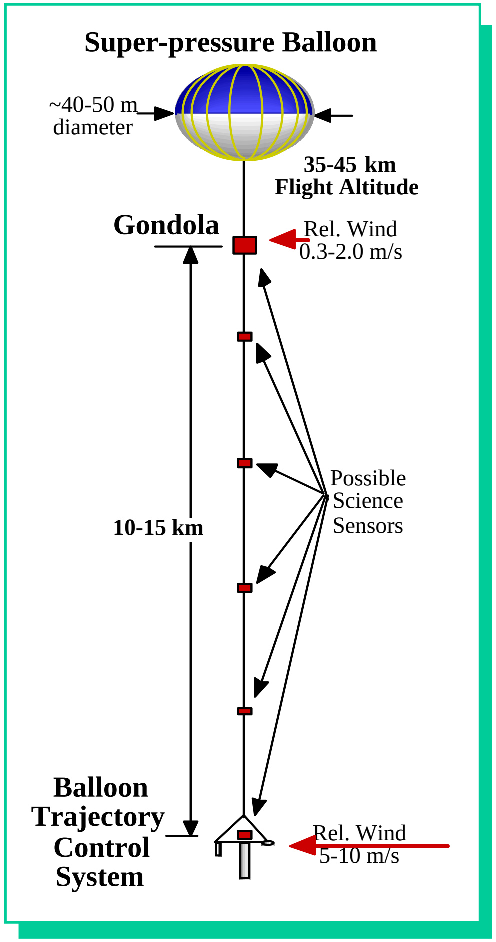
  (2) Fall into 4 solar radii from the center of the Sun at perihelion

  (3) Use an advanced- propulsion system ΔV maneuver to increase probe energy when its speed is highest to leverage rapid solar system escape

Global Constellation of Stratospheric Scientific Platforms

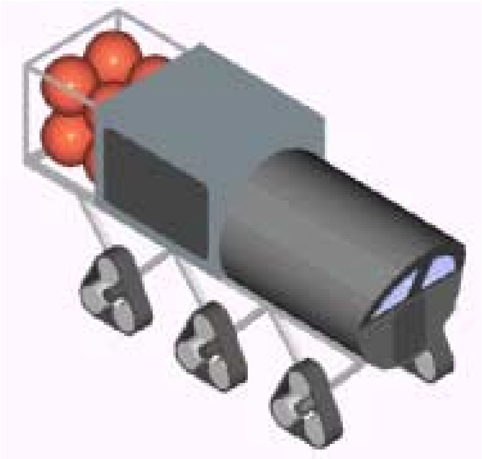
Kerry Nock, Global Aerospace Corporation

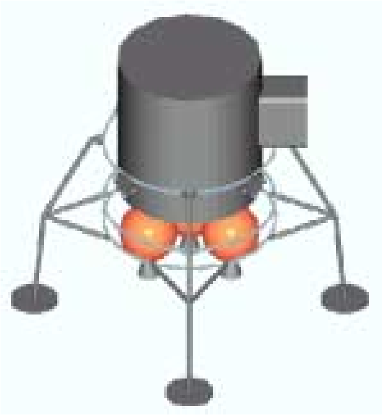




Advanced System Concept for Total ISRU-Based Propulsion and Power Systems for Unmanned and Manned Mars Exploration

Eric Rice, Orbital Technologies Corporation



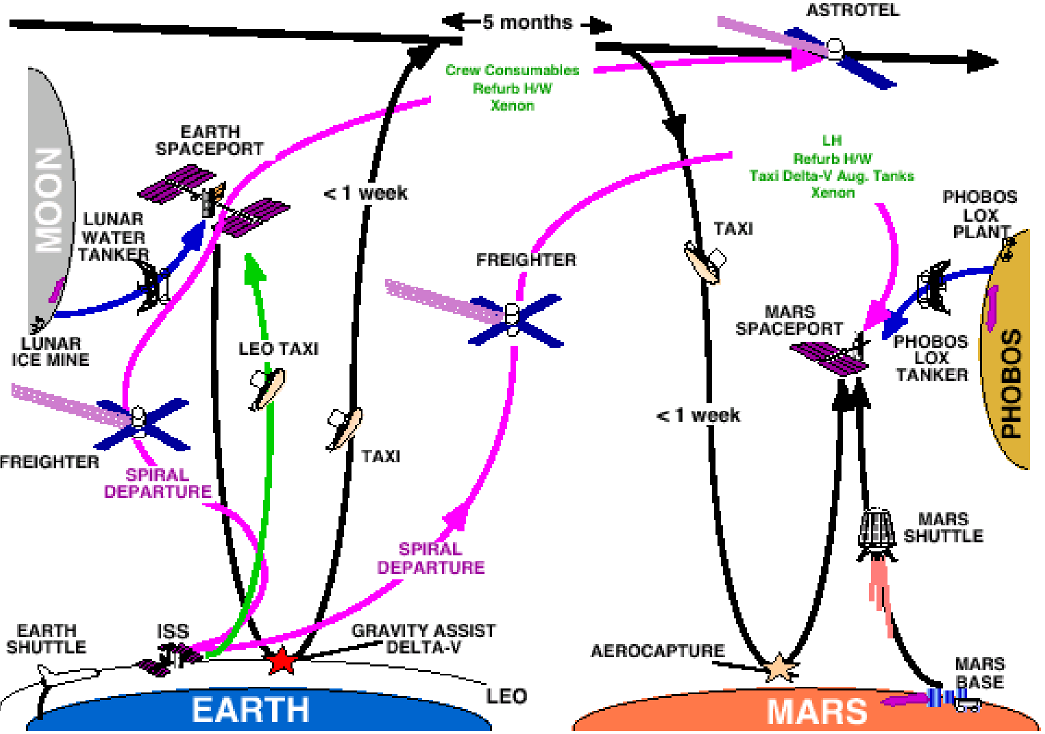


- Overall architecture for producing and utilizing Mars-based ISRU propellant combinations for ground/flight transportation and power.
- Ground systems: automated unmanned roving vehicles, personal vehicles, two-person unpressurized rovers, manned pressurized transport rovers and cargo transport.
- Flight systems: Mars sample return vehicles, manned and unmanned "ballistic hoppers," surface to orbit vehicles, interplanetary transport vehicles, powered balloons, winged aircraft, single-person rocket backpacks and single-person rocket platforms.
- Define propellant family scenarios, vehicle/system families, mission and traffic models.

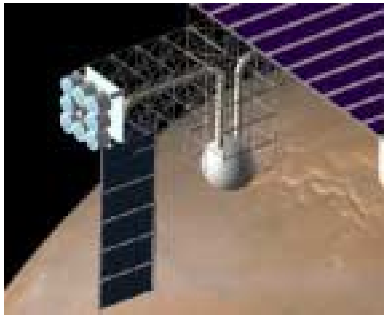
CP 00-01 Phase II Awards

PI Name and Organization	Advanced Concept Title
Nock, Kerry *Global Aerospace Corporation*	Cyclical Visits to Mars via Astronaut Hotels System
Maise, George *PlusUltra Technologies, Inc.*	Exploration of Jovian Atmosphere Using Nuclear Ramjet Flyer
Keith, Andrew *Sikorsky Aircraft Corporation*	Methodology for Study of Autonomous VTOL Scalable Logistics Architecture
Edwards, Bradley *Eureka Scientific*	The Space Elevator
Colozza, Anthony *Ohio Aerospace Institute*	Planetary Exploration Using Biomimetics

MARS TRANSPORTATION ARCHITECTURE

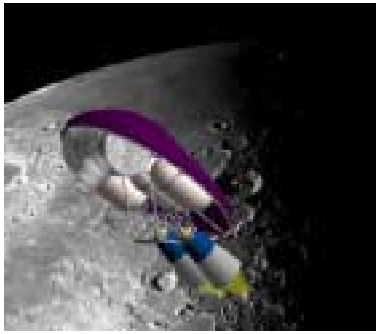


Illustrates a schematic of the overall concept for regular human visits to Mars via an Astrotel concept that uses cyclic interplanetary orbits.

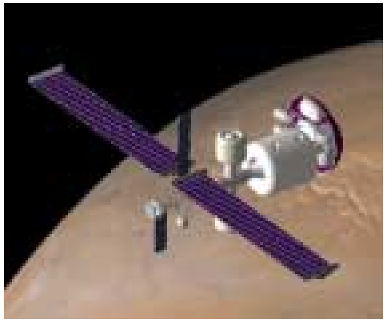


Astrotel IPS

Taxi during Mars Aerocapture

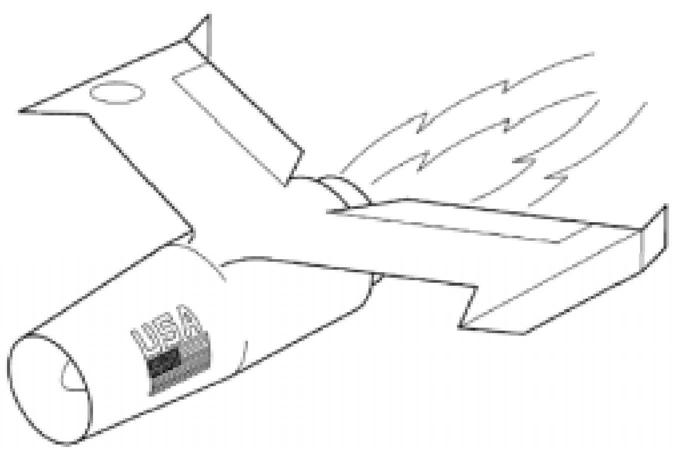


Taxi departing

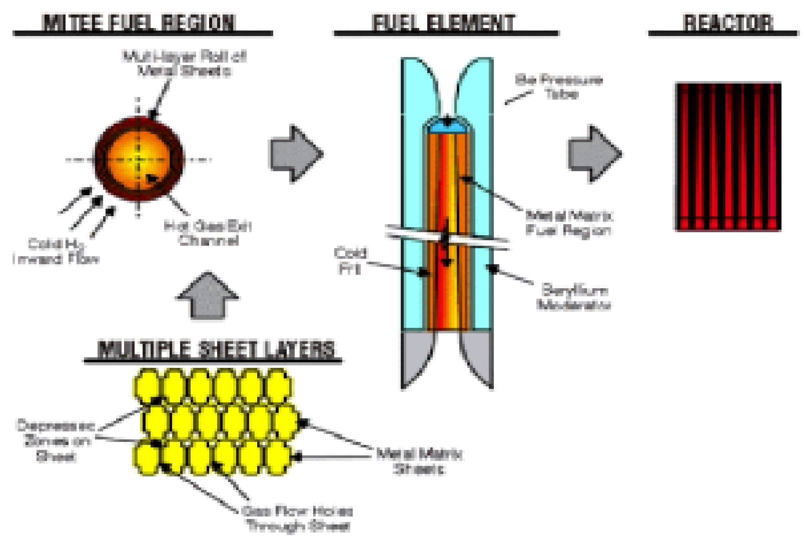


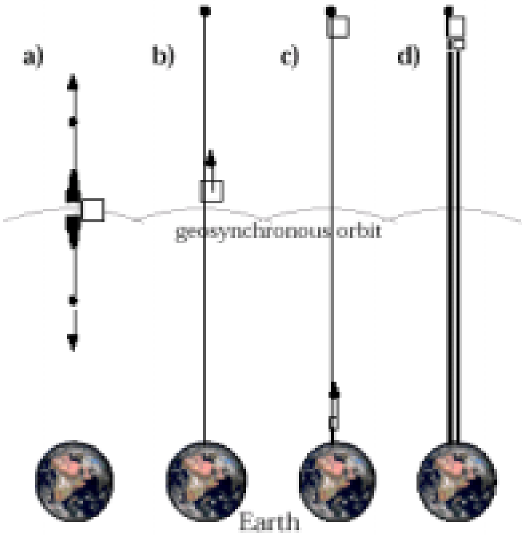
- **Ramjet flyer provides unique tool for mapping in Jovian atmosphere**
- **Applicable to other planetary atmospheres**
- **Designed to operation indefinitely in Jupiter's atmosphere**
- **Design speed, M = 1.5**
- **Instruments in wingtips for sampling**
- **Operates in the three uppermost cloud layers:**

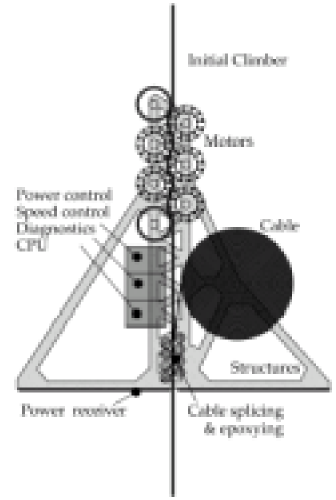
(1) Entire uppermost visible NH_3 ice cloud layer
(2) Entire NH_4HS ice cloud layer
(3) Upper portion of the H_2O ice cloud layer

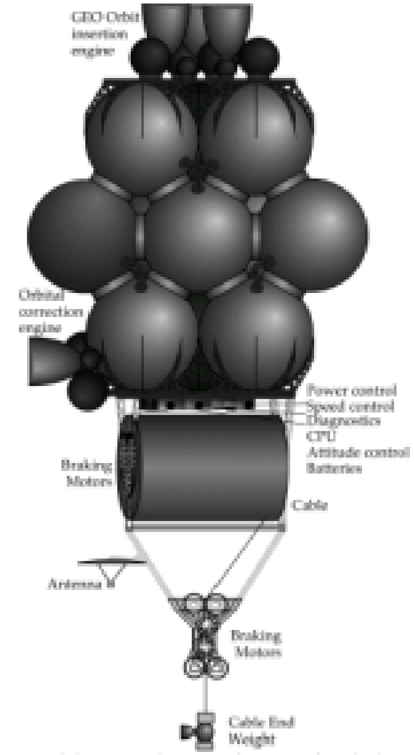


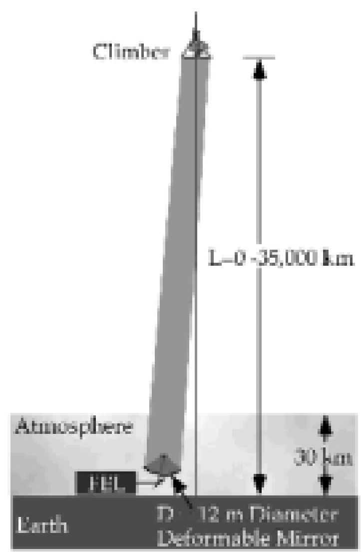
MITEE Nuclear Engine




a)
b)
c)
d)
geosynchronous orbit
Earth

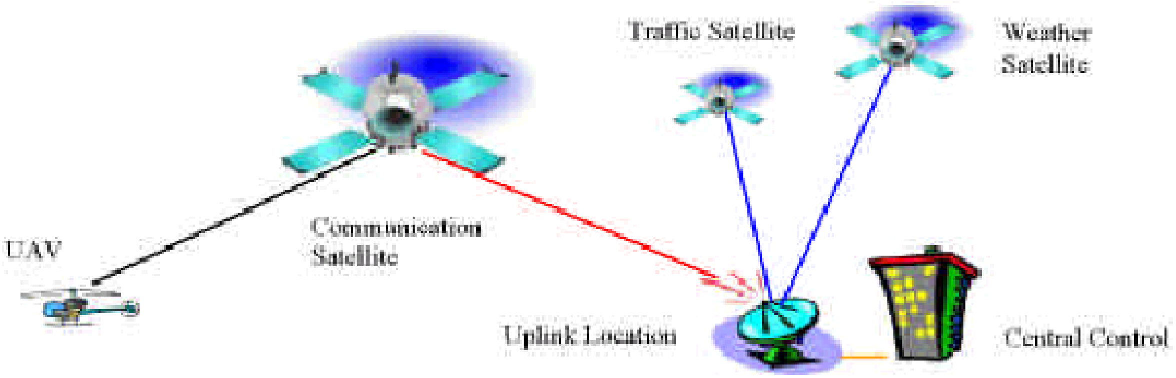

Initial Climber
Motors
Power control
Speed control
Diagnostics
CPU
Cable
Structures
Power receiver
Cable splicing
& epoxying


GEO Orbit
insertion
engine
Orbital
correction
engine
Power control
Speed control
Diagnostics
CPU
Attitude control
Batteries
Braking
Motors
Cable
Antenna
Braking
Motors
Cable End
Weight

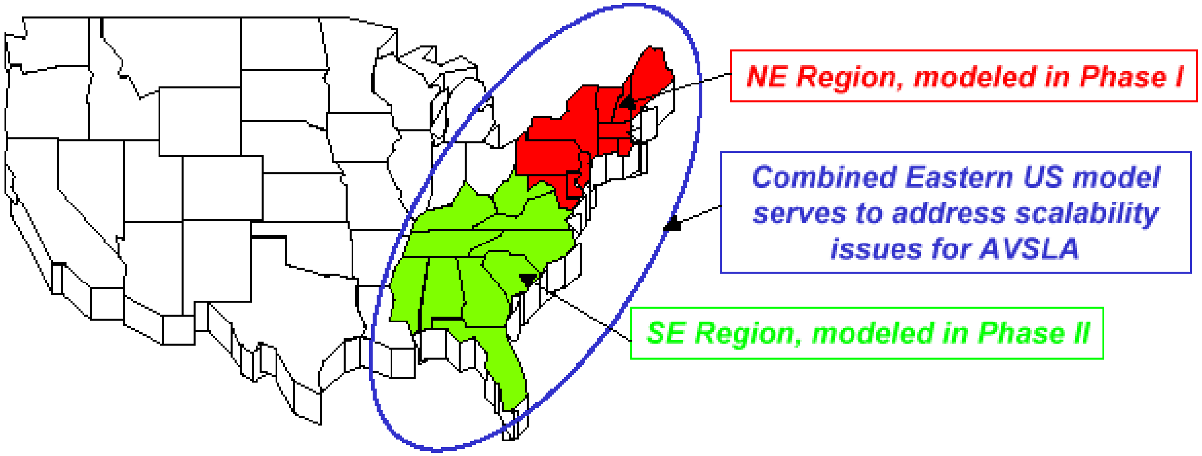

Climber
L=0 -35,000 km
Atmosphere
30 km
FEL
Earth
D 12 m Diameter
Deformable Mirror

Methodology for Study of Autonomous VTOL Scalable Logistics Architecture

Andrew Keith, Sikorsky Aircraft Corporation

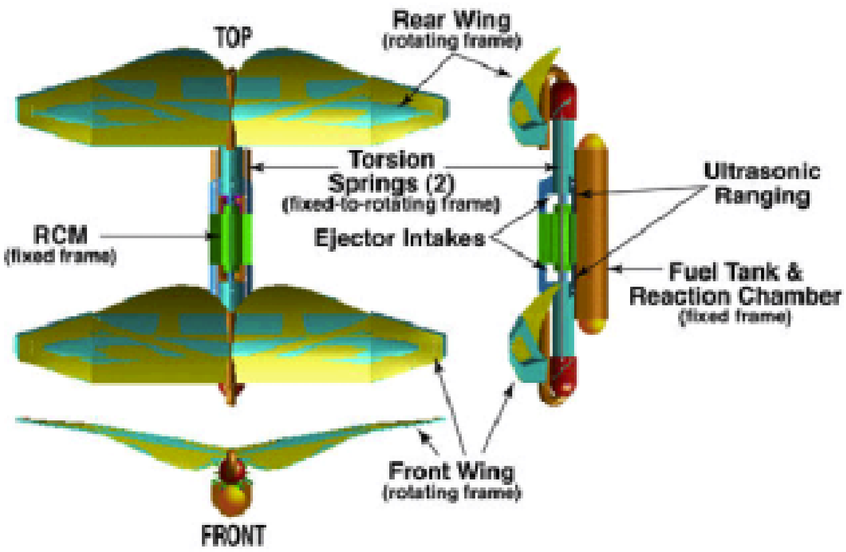


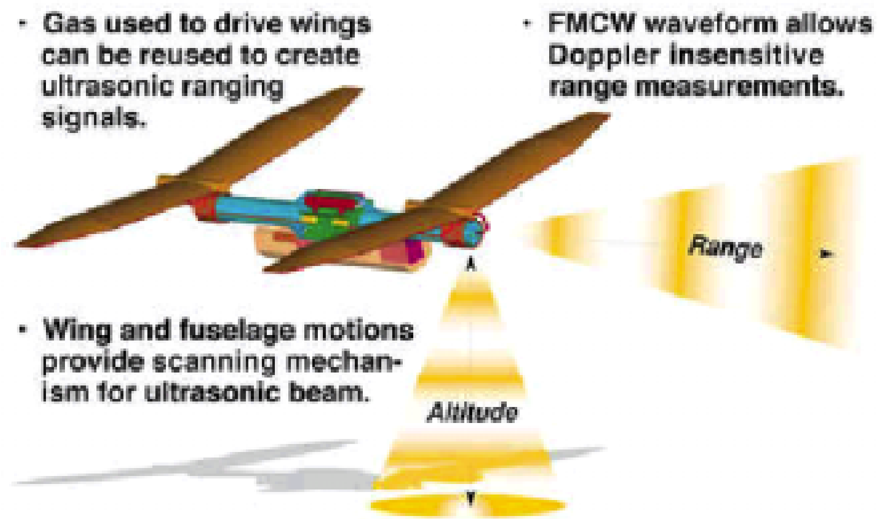
- Focused on autonomous, express package shipping services.
- Reduced travel times, improved air quality and reduction of demand on surface transportation infrastructure
- Elements relate directly to potential ATM, “free flight” applications for general and commercial aviation



<u>Phase I focus on example</u>
In-depth analysis of the current products shipped in the United States, particularly in the Northeast Region.

<u>Phase II:</u>
Expansion into SE region





- Flight in low pressure Mars atmosphere is made possible by flapping wings that can generate much higher lift coefficients at low R_e than fixed wings
- Lift and control is augmented by circulation control over wings
- Power and gas for circulation control provided by Recirculating Chemical Muscle using propellants that may be derived through ISRU